

minded in doing a great injustice to the Government of Japan, by which he was temporarily employed.  
Munich B. KOTÔ

### NOTES

AT the annual general meeting of the Society of Arts, which was held on the 27th ult., Sir William Siemens being in the chair, the following resolution relative to the death of Mr. Spottiswoode, who was a vice-president of the Society, was passed:—"That this meeting of the Society of Arts desires to express the deep regret with which it has received the news of the death of Mr. William Spottiswoode, one of its vice-presidents, and its sense of the loss which the Society has sustained by his decease. In him England loses one of her most remarkable men of science, science itself one of its greatest ornaments, and all who knew him a sincere and valued friend. Besides devoting his own time and thought to the advancement of knowledge, he was ever ready to lend to all engaged in like pursuits the assistance of his experience and his wise counsel. In thus placing on record their own appreciation of his services, the Society desires to express its feelings of sympathy with his widow and his family, and also with the Fellows of the Royal Society, of which he was the honoured and beloved President."

THE report of the Council for the past year, which was then read, makes it abundantly evident that the useful work of the Society is being carried on as successfully as heretofore. The *convenzione* of the Society previously fixed for the 11th inst. has been postponed to the 25th. On that day it will be held at the Fisheries Exhibition, South Kensington, when the Prince and Princess of Wales will be present.

INTELLIGENCE has been received from Vivi, on the Congo, of the sudden death of the well-known Swedish explorer, Capt. T. G. Een. Mr. Een, who was on his way to join Mr. Stanley on the Upper Congo, fell down dead from heart disease, just as the signal for his caravan to start was given.

THE Vienna Academy of Sciences offers two prizes of 1000 florins each (about 84*l.*) for the best treatises (1) on the capacity of various crystals for conducting electrical currents; and (2) on the chemical constitution of albumen matter.

THE well known Russian merchant Sibiriakoff is about to send another vessel to the Siberian rivers this summer. This is the steamer *Obe*, built of Bessemer steel at Motala in Sweden, and which will leave Gothenburg this week. The vessel, which is provisioned for sixteen months, is commanded by the Russian Capt. Weide, who has for many years sailed on the Yenisei and Lena. She will proceed to Tromsø, where she will meet his other steamer, the *Nordenskjöld*. A schooner with building materials will accompany the steamers as far as Novaya Zemlya, where it is intended to erect some storehouses at Yugor Scharr for the reception of cargoes when ice prevents the approach to Obi or Yenisei. At Novaya Zemlya a member of the expedition, Capt. Grönbeck, with two Samoyedes, will be left behind to study the ice and make meteorological observations during the winter. The *Obe* and *Nordenskjöld* will proceed to Port Dickson and the River Yenisei, in the mouth of which, in the Sastorovsky, the *Nordenskjöld* discharges her cargo, viz. merchandise, and loads a cargo of Siberian produce, with which she returns to Europe. The *Obe* proceeds up river with what cargo she can carry as far as Yeniseisk, and remains there for river navigation during next summer.

M. THOLLON is now working in the Observatory at Paris. We are informed that the Pic du Midi Observatory is making great progress towards completion, and that Admiral Mouchez,

M. Thollon, and other astronomers will visit it towards the end of August.

THE monthly meeting of electricians has developed into a new institution, which is to be called Société des Électriciens. A committee has been established for determining the regulations to be proposed at a general meeting next October. M. Cochéry, Ministre des Postes et Telegraphes has been appointed honorary president of the society.

A REMARKABLE instance of the fidelity and sagacity of the dog happened on Friday last at Milford Haven, and is recorded in the daily papers. Two men named Davies and Taylor were out in a boat which was swamped. The former of these was the owner of a dog, and whilst the men were struggling in the water the animal caught hold of Taylor with the object of supporting him; finding, however, that it was not his master to whom he was rendering this assistance, he relinquished his grasp and went to the aid of Davies, his master, supporting him until he was rescued by a passing steamer, the other man being drowned.

ON June 13 at about 2 p.m. an earthquake was felt in the neighbourhood of Vossevangen in Norway. There was one continuous shock lasting several seconds, accompanied by a noise as that of a heavy train passing.

A NEW electric boat, exceeding in size all that have hitherto been designed, is now being fitted up at Millwall by the Electrical Power Storage Company, and is, we understand, nearly ready for her formal trial trip. The new craft is of iron, and measures forty-six feet in length. Her "engine" is a Siemens' dynamo of the D2 type, and works direct on the screw shaft without any gearing. The screw is of unusually narrow pitch, in order to enable the dynamo to run with a high velocity. She carries sixty-five accumulators of the Faure-Sellon-Volckmar pattern of the same size as those used in the smaller electric boat constructed last autumn by the same company. In the private trials made, a speed of eight miles per hour was maintained. This boat will be sent to Vienna, and will doubtless attract much notice at the forthcoming Electrical Exhibition in that city.

RIGNOLD's panorama of the Arctic regions will be exhibited at the Royal Victoria Coffee Hall during the present month. This panorama, which was painted by the late Clarkson Stanfield, R.A., has the reputation of being the finest marine painting extant.

UNDER the title of "Hardy Perennials and Old-fashioned Flowers" Mr. L. Upcott Gill of 170, Strand, has issued the first number of what will be, if carried out on the lines here laid down, a rather bulky book, and moreover an expensive one, inasmuch as the number before us, which bears date April, is priced at 6*s.*, contains only forty-eight pages, and proceeds only to CAL in an alphabetical arrangement of the names of the flowers which are recommended for cultivation. The aim of the work is a good one, namely, the bringing to notice many flowers for cultivation in our gardens that are now totally neglected or forgotten. Many old familiar friends are brought to mind in glancing through these forty-eight pages. The arrangement of the plants in alphabetical order of their scientific names is the best that could have been adopted. The wholesale use of capital letters for the specific names should be altered, and more care should be taken in the spelling, such mistakes occurring as *Achillea Aegyptica* for *ægyptiaca*, *Calthus* for *Caltha*, &c. Some of the figures also are extremely poor.

SINCE the above was written we have received the June number of this little work, which brings it down to *Helleborus* or the Christmas Rose. In this latest number the same lavish use of capitals occurs for the initial letter of the specific name

and the average number of mistakes also occurs. Thus under the genus *Funkia* the common name given is *Planting Lily*, whereas it should be *Plantain Lily*, a name that has been quite recently accorded to these plants by a gardening contemporary.

THE annual Reports of Colonial Botanical Gardens are so frequently reaching us and the matter contained in them is of such value and importance that we regret we have not space at our disposal to give a more extended notice of some of these records of scientific work in our widely spread dependencies. Two of these reports lie before us, namely, that of Dr. Trimen on the Royal Botanic Gardens, Peradeniya, Ceylon, for the year 1882, which report is dated at Peradeniya on January 1 of the present year, and that of Mr. Charles Ford on the Hong Kong Gardens, or rather on his work as Superintendent of the Botanic and Afforestation Department, Hong Kong. A large portion of Dr. Trimen's report is given to the consideration of economic plants, the first mentioned being coffee. Under this head it is with no satisfaction we learn that "Leaf disease has in no degree diminished, and the continued failure of crop during the past year has added to the difficulties of all concerned in the planting enterprise of the colony." Dr. Trimen continues, "No combined effort whatever to prevent the disease on the lines indicated by its known nature has been even attempted, whilst the waste of money and time in local applications of 'cures' has continued. As at the same time high cultivation and liberal manuring have become generally impossible from pecuniary necessities, the existing state of things, however much to be lamented, cannot be considered surprising. A remarkably wet season, too, has aggravated the condition of the badly nourished trees, and the low prices ruling for coffee have intensified the loss by short crops. Thus the cultivation of coffee has been in many places found not to cover expenses, and the necessity of growing other products has been more than ever forced upon proprietors." From this we gather that the prospects of coffee cultivation in Ceylon are anything but promising, and with regard to Liberian coffee, upon which the hopes of planters were at one time founded, we find that it likewise has had to bear the severe attacks of leaf disease, and consequently rises and falls in the estimation of planters. In suitable soils and localities, however, it does well, and the old trees now between eight and nine years old, though badly diseased, show no diminution in their crop-bearing capabilities. No record however is kept of the exports of Liberian coffee from Ceylon distinct from the produce of the other kind. Dr. Trimen remarks that the *Hemileia* not unfrequently attacks the fruits of Liberian coffee. As might be supposed, the subject of cinchona cultivation occupies a large portion of the report, and next to it comes tea and cocoa. The past year, we are told, has witnessed a very striking rise in the export of the first-named beverage, the exports amounting to 623,292 lbs., an advance on the previous year of 345,702 lbs. Tea estates have been opened at all elevations, and many old coffee estates not suited for cinchona culture are now cropped with tea. Indiarubber, gutta-percha, and many other industrial and medicinal plants come under Dr. Trimen's review of a year's work at Ceylon, proving once more, if proof were needed, the value of the Peradeniya Gardens amongst others in promoting the advance of applied botany; and the same may be said of Mr. Ford's report of the Hong Kong Garden, for we find there that a considerable amount of attention has been given to the growth of such plants as *Cinnamomum cassia*, the tree furnishing Cassia Ligna of the London market, the Chinese varnish tree (*Aleurites cordata*), and the mahogany tree (*Swietenia mahoganii*).

A NEW form of dry pile has been described in *Wiedemann's Annalen* by J. Elster and H. Geitel. In the previous forms of dry pile, from the time of Zamboni downwards, the disks of foil and paper have been placed in glass tubes, with the result that

the film of moisture collecting on the inner surface of the tube has always exerted a more or less destructive influence. In the new dry piles the disks are strung with a sewing-needle upon a single strong silk thread, which insures better insulation. Messrs. Elster and Geitel have made the very interesting observation that piles of this type can be charged from a Holtz machine. An ordinary Zamboni pile of 11,000 pairs of disks of tin and copper foil gave, after ten minutes' charging, sparks one millimetre long, and was able to illuminate a small Geissler tube for some time with a discharge continuous at first and afterwards intermittent. Following up this analogy dry piles were constructed on the plan of a Planté battery. Thin disks of lead foil alternating with disks of silk paper painted with a mixture of soluble glass and peroxide of lead were strung upon silk strings. A charged pile of 7000 such plates gave for ten minutes a spark one millimetre long; and after twenty four hours still showed electrification.

THE last report of the British Consul at Tientsin supplies us with information respecting the only colliery at present in complete working order in China. This is at Kaiping, not far from Peking. The coal is said to belong to the true carboniferous system, and the bed dips to the south some forty-five degrees, forming a large basin under the Gulf of Pehchihli. No fear is entertained that the measures will run short. So far as has been ascertained, the coal bearing stratum is about one thousand feet, containing thirteen seams. During the winter months two hundred tons per day of the inferior kinds of coal can be sold to natives in the vicinity, who use it for pottery, brick, and lime-kilns; indeed, one of the most important results achieved by the opening of the colliery has been the revival of several industries in the vicinity which were languishing or extinct, on account of the surface coal of the district being mostly worked out, and the price of other coal being too high to be used with profit. In connection with the colliery is a small railway, the only one in all China. Its length is but six and a half miles, and at the terminus the coal is placed in barges and carried down by canal. After a little opposition the locomotives were allowed to run freely. But ironworks, which it was also intended to start, could not get over the superstitious opposition raised on the score of the proximity of the Imperial tombs, and the consequent geomantic disturbances caused by sinking shafts, &c. The iron ore is said to exist in enormous quantities, but it is not easy to work owing to the amount of silica present.

WE have received Parts 4-6 of the *Transactions of the Yorkshire Naturalists' Union*, which do credit to that energetic body of local naturalists. They are entirely occupied by lists and notes concerning the fauna and flora of this, our largest, county, so arranged that each subject has a separate pagination, and most of the authors give evidence of considerable bibliographical research; some of the articles are of far more than local importance.

FROM several parts of Sweden the appearance of an unknown caterpillar, which consumes the crops, is reported. Its length is from one inch to one and a half, and its colour grey-brown with green stripes. In one place it put in an appearance immediately after a violent storm with rain. The Academy of Agriculture has despatched an entomologist to visit the places from which it is reported.

THE German Society of Analytical Chemists offers two prizes, of 25*l.* and 15*l.* respectively, for the best treatises on cocoa and cocoa manufactures, with reference to their commercial value and efficacy in nutrition.

ADMIRAL MOUCHEZ will not be reappointed at the expiration of his term of office. The Government is fully convinced that it is useless to resort to this formality, and that it would be better to continue his appointment by *toute réconduction*, as is customary in France under peculiar circumstances.



MISS FIELDE, an American missionary lady stationed at Swatow, has, it is stated, completed a voluminous dictionary of the Swatow dialect, which will be published shortly.

THE additions to the Zoological Society's Gardens during the past week include a Feline Dourocouli (*Nyctipithecus vociferans* ♀) from Columbia, presented by Mr. H. H. Thiele; an Indian Civet (*Viverricula indica* ♀) from India, presented by Capt. Wilson; two Squirrel-like Phalangers (*Belideus sciureus*) from Australia, presented by A. Pretyman; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. J. E. Dothie; an Australian Crow (*Corvus australis*) from Australia, presented by Mrs. A. H. Jamrach; a Nicobar Pigeon (*Calenas nicobarica*) from the Philippine Islands, presented by Mr. Hugh Low; two Common Gulls (*Larus canus*), British, presented by Mr. C. W. Jervis Smith; a Spotted Mud Frog (*Pelodytes punctatus*) from the South of France, presented by Mr. H. P. Cambridge; a Cape Ant Bear (*Orycteropus capensis*), twelve Derbian Zonures (*Zonurus derbianus*) from South Africa, two Canadian Beavers (*Castor canadensis* ♂ ♀) from Canada, a Viperine Snake (*Tropidonotus viperinus*) from North Africa, a Tree Boa (*Corallus hortulanus*) from South America, purchased; a Hairy-footed Jerboa (*Dipus hirtipes*) from Arabia, a Simon's Dwarf Jerboa (*Dipodillus simoni*) from Algeria, received in exchange; a Japanese Deer (*Cervus sika* ♂), a Hybrid Syrian Wild Ass (between *Equus hemippus* ♂ and *Equus onager* ♀), an Impeyan Pheasant (*Lophophorus impeyanus*), four Amherst's Pheasants (*Thaumalea amherstiae*), bred in the Gardens.

#### ON THE CAUSES OF GLACIER MOTION<sup>1</sup>

THE question of the causes which produce the movement of glaciers, which was at one time so eagerly discussed, would appear to have slumbered for the last ten years. This cannot be said to arise from the fact that a perfectly satisfactory theory has been developed, and recognised as such by all inquirers. The ambiguous allusion to the subject in Sir John Lubbock's presidential address to the British Association is an evidence that such certainty has not been attained. It is indeed generally supposed that the fact of the melting-point of ice being lowered by pressure is somehow at the root of the matter; but a full explanation of the origin of this pressure in the case of glaciers and of the mechanical features of the problem has yet to be given. I may therefore be pardoned if I draw attention to a different solution, proposed not by myself but by one of the greatest of English mechanicians. My apology for doing so is that I approach the question as an engineer, not as a physicist; and that it is in its essence, as will be shown immediately, a mechanical rather than a physical problem.

The following are leading facts of glacier-motion which must be accounted for by any valid theory on the subject:—

(1.) The phenomena of the movement of a glacier are simply those of a solid body in a state of flow.

(2.) The present glaciers of Switzerland and Norway, which are the only ones which have been critically examined, are mere shrunken fragments of the glaciers of the Great Ice Age. To take one instance, the present glacier of the Rhone is about 6 miles long and perhaps 500 feet deep; but the old glacier of the Rhone, which abutted against the Jura, was 120 miles long, and must have been 2000 to 3000 feet deep. The movement of such glaciers as this must also be accounted for in any satisfactory theory.

(3.) The glaciers of the present day are not confined to the temperate region; they are found in much larger numbers and of much greater size in the Arctic regions.

(4.) Both in the temperate and in the Arctic regions glaciers move in winter as well as in summer, and by night as well as by day.

That a glacier is in a state of flow was first proved by Forbes, and has since been confirmed by the measurements of Tyndall and others. Whilst the whole mass moves downwards, the top moves faster than the bottom and the sides than the middle; the upper layers must therefore be continually shearing over the

lower, and the medial over the lateral. A glacier, being a body in a state of flow, must move under the influence of forces powerful enough to overcome its resistance, and so produce this condition.

The general phenomena of the motion of a glacier are exactly reproduced when a viscous body moves through a channel under the influence of its own weight. We have therefore first to inquire whether the shearing resistance of ice is sufficiently low to enable us to regard a glacier as a viscous mass.

The only experiments known to me on the shearing resistance of ice, are those of Moseley (*Phil. Mag.*, January, 1870). He found that, with pressures from 100 to 110 lbs. per square inch, cylinders of ice sheared slowly across the two planes in contact, sliding over each other without losing continuity. The distance sheared through was about five-eighths of an inch in half an hour. A load of 119 lbs. per square inch was sufficient to shear through a cylinder of 1½ inches in diameter in two to three minutes. From these experiments it would appear that the lowest shearing stress which will cause ice to flow is about 100 lbs. per square inch; but sufficient time was not allowed in the experiments to make this a matter of certainty.

There is another way in which the shearing resistance of ice may be tested. In the case of a block of ice of vertical sides, gravity of course produces a shearing resistance along all planes passing through the base. Let  $h$  be the height of such a block in feet, and consider the shearing force due to gravity on any square foot of a plane making an angle  $\theta$  with the vertical. This shearing force is given by—

$$\frac{wh \times h \tan \theta}{2} \times \cos \theta = \frac{wh}{2} \sin \theta \cos \theta.$$

This expression is a maximum when  $\theta = 45^\circ$ , and its value is then—

$$\frac{wh}{4}.$$

What is the greatest height at which a vertical cliff of ice will stand? I am not able to state this precisely, but it is very considerable. Mr. Whymper mentions crevasses in South America 300 feet deep. Cliffs of fully that height have been seen standing out of water in the case of icebergs, and as so small a part of an iceberg projects above water, these cliffs probably extend below to a considerable depth. Taking, however, only 300 feet for the value of  $h$ , or for the maximum height of an ice cliff, this would give about 30 lbs. per square inch as the lowest shearing force upon a plane of ice which would cause it to assume the condition of flow.

Let us now suppose a glacier of thickness  $a$ , lying upon a slope whose inclination to the horizontal is  $\beta$ ; then the force per square foot, tending to shear the ice at its junction with the slope, is clearly  $aw \sin \beta$ .

Supposing  $\sin \beta$  to equal  $\frac{1}{4}$ , and that the shearing resistance is 30 lbs. per square inch, we get  $a =$  about 290. Hence we may say that a glacier lying on a slope of 1 in 4 will not move at all under its own weight unless it be at least 300 feet thick, and that, if it be more than this, the upper 300 feet will move as one solid mass, the part below alone representing the conditions of flow.

It is needless to say that there are hundreds of glaciers which are less than 300 feet thick, and which at no part of their course have a slope anything approaching 1 in 4.

We have now to show that the theories generally propounded for glacier action are all of them negatived by some of the foregoing considerations. These theories may be stated as follows:—

(1.) The glacier simply slides over its bed as a solid body. This is negatived by the fact that some parts move faster than others.

(2.) The glacier flows under the action of its own weight, exactly as a viscous body flows. This is the theory of Forbes. It is disproved by the facts given above, which show that even on a slope of 1 in 4 a glacier would not flow unless it was at least 300 feet thick.

(3.) The glacier moves by the crushing of its base. This has been disproved by Moseley's experiments, which showed that the crushing resistance of ice was considerably higher than the shearing resistance.

(4.) The glacier moves by the melting of its base. This is the theory of Hopkins. He placed a block of ice at  $32^\circ \text{F.}$  on a slab at a small angle, and found that it slowly descended as it melted. On this view the bottom of the glacier must always

<sup>1</sup> Paper by Walter R. Browne, M.Inst.C.E., read at the Royal Society, June 15, 1882.